MASTER'S THESIS

The Mediating Role of Breakfast Consumption in the Relationship between BMI and School Performance in Prevocational Secondary Education Students

de Bats-van Hoof, Marleen

Award date:
2019

The Mediating Role of Breakfast Consumption in the Relationship between BMI and School Performance in Prevocational Secondary Education Students

De Mediërende Rol van Ontbijt Consumptie in de Relatie tussen BMI en School Prestaties bij Leerlingen in het Voorbereidend Middelbaar Beroeps Onderwijs

Marleen de Bats – van Hoof

Master Onderwijswetenschappen
Open Universiteit

Datum: 11 September 2019
Begeleiding: Dr. Inge van der Wurff

Table of contents

The Mediating Role of Breakfast Consumption in the Relationship between BMI and School Performance in Prevocational Secondary Education Students

Marleen de Bats – van Hoof

Summary

Background - Although frequency of breakfast consumption has previously been related to BMI and school performance, these relationships have not been investigated in prevocational secondary education students, among whom breakfast skipping and overweight are most prevalent. **Aim -** The first aim of this study was therefore to expand previous work, by investigating the relationship between frequency of breakfast consumption and school performance, the relationship between frequency of breakfast consumption and BMI and the relationship between BMI and school performance in prevocational secondary education students. The second aim was to investigated whether frequency of breakfast consumption mediates the relationship between BMI and school performance. **Participants, procedure, design –** To be included students had to be in the theoretical learning pathway from the first grade until their present grade without skipping or repeating grades. In addition they had to take mathematic class. With these selection criteria a total of 249 students received an information letter and informed consent form and their classes were visited by the researcher. The final sample consisted of 65 participants, 41.5% boys and 58.5% girls, aged 12 to 17 years (M = 14.03, SD = 1.46). Among them a cross-sectional, correlational design was conducted. **Measures -** Data on age, sex, bodyweight and height and frequency of breakfast consumption was obtained from a student questionnaire, data on level of parental education was obtained from parents/caregivers by a short questionnaire (De Bie, 1987). School performance was operationalised as school grades, standardized to z-scores per grade. Multiple regression and mediation analysis were conducted . **Results -** LPE was low-medium in 47.7% and high in 52.3% of the participants. Participants had a mean breakfast frequency of 5.09 (SD = 2.31) days per week and a BMI of 21 (SD = 3.11). No significant correlations between frequency of breakfast consumption and standardized school grades (r = .19, p = .13) and frequency of breakfast consumption and BMI (r = -.17, p = .19) were found. The relationship between BMI and school performance was found to be nearly nil r = .02, p = .90. Hierarchical multiple regression analysis with LPE, age and sex as background variables showed similar results. Because no significant relation between BMI and school performance was found the mediation analysis added no valuable information. When frequency of breakfast consumption was exploratively dichotomized a significant relation between this variable and BMI was found (r = -.39, p < .01). **Conclusion –** Although the relationships between frequency of breakfast consumption and school performance and between frequency of breakfast consumption and BMI were not significant our results indicated that these relationships might exist in a larger sample. The main limitation of this study is the small number of participants. It is therefore recommended to investigate

the relationship between frequency of breakfast consumption, school performance and BMI among prevocational education students in the Netherlands on a larger scale.

Keywords: Breakfast consumption, adolescents, BMI, school performance, prevocational secondary education.

De Mediërende Rol van Ontbijt Consumptie in de Relatie tussen BMI en School Prestaties bij Leerlingen in het Voorbereidend Middelbaar Beroeps Onderwijs

Marleen de Bats – van Hoof

Samenvatting

Achtergrond – Hoewel ontbijtfrequentie in voorgaand onderzoek werd gerelateerd aan BMI en schoolprestatie, zijn deze relaties nog niet onderzocht onder leerlingen van het Voorbereidend Middelbaar Beroeps Onderwijs (VMBO). Onder VMBO leerlingen is het percentage dat ontbijt overslaat en het percentage overgewicht het hoogst. **Doel –** Het eerste doel van deze studie was dan ook uitbreiding van voorgaand onderzoek, door de relatie tussen ontbijtfrequentie en schoolprestatie, de relatie tussen ontbijtfrequentie en BMI en de relatie tussen BMI en schoolprestatie onder VMBO leerlingen te onderzoeken. Het tweede doel was om te onderzoeken of ontbijtfrequentie een mediërende rol speelt in de relatie tussen BMI en schoolprestatie. **Deelnemers, procedure, onderzoeksontwerp –** Voorwaarde voor deelname waren het volgen van onderwijs aan de VMBO theoretische leerweg vanaf het eerste leerjaar tot aan het huidige leerjaar, zonder een klas gedoubleerd of overgeslagen te hebben met wiskunde in het vakkenpakket. Tweehonderd negenenveertig leerlingen ontvingen een informatie brief en toestemmingsverklaring en hun klassen werden bezocht door de onderzoeker. Dit leverde 65 deelnemers op, 41.5% jongens en 58.5% meisjes, in de leeftijd van 12 tot 17 jaar (M = 14.03, SD = 1.46). Onder hen werd een cross-sectioneel, correlationeel onderzoek uitgevoerd. **Meetinstrumenten -** Data met betrekking tot leeftijd, sekse, lichaamslengte en -gewicht en ontbijtfrequentie werden verkregen via een leerling vragenlijst. Data met betrekking tot het opleidingsniveau van ouders werd verkregen van de ouders via een korte vragenlijst (De Bie, 1987). Schoolprestatie werd geoperationaliseerd als schoolcijfers, gestandaardiseerd tot z-scores per leerjaar. Meervoudige regressie en mediatie analyse werden uitgevoerd. **Resultaten -** Opleidingsniveau van ouders was laag-medium in 47.7% en hoog in 52.3% van de deelnemers. De gemiddelde ontbijtfrequentie van de deelnemers was 5.09 (SD = 2.31) dagen per week en het gemiddelde BMI was 21 (SD = 3.11). Er werden geen significante correlaties gevonden tussen ontbijtfrequentie en gestandaardiseerde schoolcijfers (r = .19, p = .13) en tussen ontbijtfrequentie en BMI (r = -.17, p = .19) De gevonden relatie tussen BMI en schoolprestatie was nihil r = .02, p = .90. Hiërarchische meervoudige regressie analyse met opleidingsniveau van ouders, leeftijd en sekse als achtergrond variabelen toonde vergelijkbare resultaten. Omdat er geen significante relatie tussen BMI en schoolprestatie gevonden werd was een mediatie analyse niet meer van toegevoegde waarde. Wanneer ontbijtfrequentie exploratief werd gedichotomiseerd werd er een significante relatie gevonden tussen ontbijtfrequentie en BMI(r = -.39, p < .01). **Conclusie –** Hoewel de gevonden relaties tussen ontbijtfrequentie en schoolprestatie en tussen ontbijtfrequentie en BMI niet significant zijn duiden de resultaten erop dat de relaties kunnen worden aangetoond in een grotere steekproef. De voornaamste

beperking van deze studie is het kleine aantal deelnemers. Het is daarom aan te bevelen om de relaties tussen ontbijtfrequentie, BMI en schoolprestaties onder VMBO leerlingen in Nederland op grotere schaal te onderzoeken.

Trefwoorden: Ontbijtfrequentie, ontbijt consumptie, adolescenten, BMI, schoolprestatie, VMBO.

1. Introduction

1.1 Problem definition

Breakfast has often been considered the most important meal of the day. Consuming breakfast may be positively related to diet quality, weight control, feelings of well-being and other health benefits (Rampersaud, Pereira, Girard, Adams, & Metzl, 2005). Moreover, breakfast consumption has also been related to cognitive performance and school performance in children and adolescents (e.g. Adolphus, Lawton, & Dye, 2013; Adolphus, Lawton, Champ, & Dye, 2016; Hoyland, Dye, & Lawton, 2009; Rampersaud et al.,2005; Rampersaud, 2008).

One of the possible health benefits of breakfast consumption is a reduced risk of overweight and obesity in children and adolescents whom consume breakfast (e.g. Rampersaud et al. 2005; Rampersaud, 2008). Overweight and obesity are more prevalent among breakfast skipping children and adolescents than among those who consume breakfast regularly (So et al., 2011; Tee et al., 2018). Moreover, a negative relationship between body mass index (BMI) and frequency of breakfast consumption in adolescents has been shown. Meaning that infrequent breakfast consumers seem to have a higher BMI than adolescents who regularly consume breakfast (Keski-Rahkonen, Kaprio, Rissanen, Virkkunen, & Rose, 2003; Larsen, Kleinjan, Engels, Fisher, & Hermans, 2014). The relationship between BMI and breakfast consumption might be bidirectional. Breakfast consumption might influence BMI, but BMI might also influence breakfast consumption, because adolescents with higher BMI might choose to skip breakfast to lose weight (Keski-Rahkonen et al., 2003; Rampersaud et al., 2005; Rampersaud, 2008).

The possible relationship between BMI and breakfast deserves attention because of the increasing prevalence of overweight and obesity among children and adolescents during the past decennia. In 2017 12.6% of Dutch adolescents aged 12-16 years was overweighed. This is an obvious increase from the 6.6% in 1991 and 9.8% in 2001 in that age group (Centraal Bureau voor de Statistiek, 2018a). High BMI scores are not only associated with many health risks, a higher BMI has also been related to poorer school performance (Caird et al., 2013; Crosnoe & Muller, 2004; Shore et al., 2008). Larsen et al. (2014) demonstrated that a high BMI score is a predictor for moving to a lower educational level among Dutch secondary school students. Furthermore, Vissers et al. (2008) found a significant higher prevalence of overweight and obesity in Belgian students attending the prevocational and vocational educational level, compared to Belgian students attending higher educational levels.

Besides its relationship to BMI, breakfast consumption itself has also been positively associated with school performance. Adolphus et al. (2013) reviewed studies in which the relationship between breakfast consumption and school performance was investigated. They reported a positive relationship between frequency of breakfast consumption and school performance in children and adolescents (i.e. more frequent breakfast consumption, better school performance).

Despite the possible benefits of breakfast consumption several studies have found that between 20% and 30% of children and adolescents skip breakfast (Adolphus et al., 2016; Raaijmakers, Bessems, Kremers, & Van Assema, 2010). This percentage seems to be higher in children with lower socioeconomic backgrounds, girls and older children and adolescents (Rampersaud et al., 2005). Given the possible favourable association between frequency of breakfast consumption, BMI and school performance, these percentages of breakfast skipping are alarming. Therefore, gaining more insight into the relationships between frequency of breakfast consumption, school performance and BMI is useful.

Boschloo et al. (2012) found a relationship between breakfast skipping and school performance in Dutch adolescents, but their investigation did not include students of prevocational secondary education, among whom breakfast skipping (Raaijmakers et al., 2010) and overweight (Vissers et al., 2008) are most prevalent. Therefore, the first aim of this pilot study was to expand the work of Boschloo et al. (2012) by investigating the relationship between frequency of breakfast consumption and school performance, the relationship between frequency of breakfast consumption and BMI and the relationship between BMI and school performance in prevocational secondary education students (see Figure 1). The second aim was to investigate whether frequency of breakfast consumption mediates the relationship between BMI and school performance. As shown in Figure 2, frequency of breakfast consumption was analysed as possible mediator of the relationship between BMI and school performance.

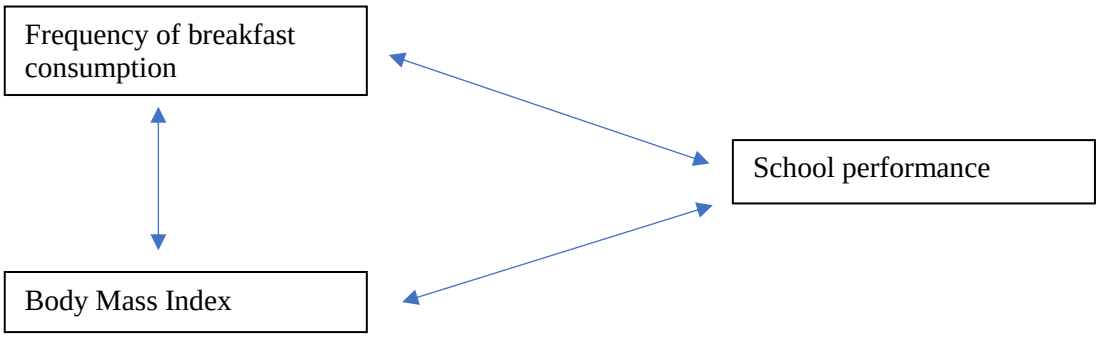

Figure 1. Investigated relations. The arrows indicate the relations that have been investigated in the present study.

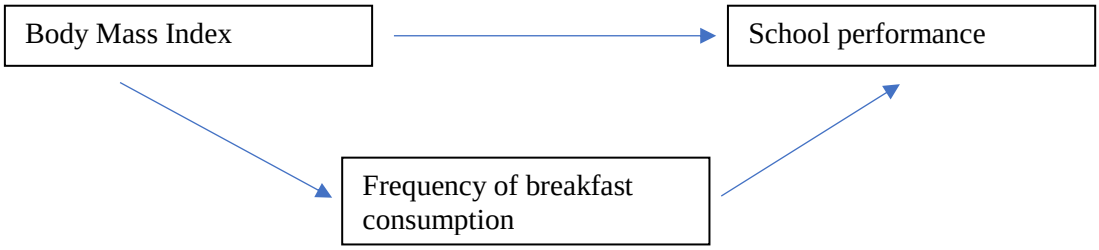

Figure 2. Frequency of breakfast consumption as mediator. This figure presents a model in which frequency of breakfast plays a mediating role in the relation between the variables BMI and school performance.

1.2 Theoretical Background

1.2.1 Frequency of breakfast consumption and school performance in adolescents.

Few studies have investigated the relationship between frequency of breakfast consumption and school performance. However, such studies can provide meaningful information to students, their parents and teachers (Adolphus et al., 2013). Adolphus et al. (2013) reviewed studies that investigated the relationship between breakfast consumption and school performance. School performance was either measured as school grades or standardized achievement tests. In the review five studies in which the effect of breakfast frequency on school grades was investigated were included. These studies consistently demonstrated a positive association between frequency of breakfast consumption and school grades in adolescents.

One of the studies included in the review of Adolphus et al. (2013) was performed in the Netherlands (Boschloo et al., 2012). They found a significant, but small *(β=.15)* positive relationship between breakfast consumption and school grades (i.e. consuming breakfast every weekday was related to higher school grades than skipping breakfast at least one weekday). The investigation of Boschloo et al. (2012) did not include students of prevocational secondary education, among whom breakfast skipping (Raaijmakers et al., 2010) and overweight (Vissers et al., 2008) are most prevalent.

In contrast to the relationship between frequency of breakfast consumption and school performance, the relationship between frequency of breakfast consumption and cognitive functions has been investigated more intensively. Even though, school performance is dependent on many more factors than cognitive functioning alone e.g. personality and motivation (Boschloo, 2012), cognitive functioning and school performance have been found to be significantly related (Bartels, Rietveld, Van Baal, & Boomsma, 2002; Best, Miller, & Naglieri, 2011; Deary, Strand, Smith, & Fernandes, 2007). It is therefore assumed that cognitive functioning underlies school performance (Boschloo et al., 2012) Results of studies in which the relationship between frequency of breakfast consumption and

cognitive functioning are investigated might therefore be valuable to understand the relationship between frequency of breakfast consumption and school performance.

Adolphus et al. (2016) and Hoyland et al. (2009) systematically reviewed studies on breakfast consumption and cognitive functioning. They concluded from experimental studies in which breakfast versus no breakfast conditions were compared, that breakfast consumption relative to breakfast skipping has an acute beneficial effect on cognitive functioning. This effect is domain-specific; positive effects of breakfast relative to breakfast skipping were found for tasks requiring attention, executive functioning and memory (Hoyland et al., 2009; Taras, 2005). Results from longer-term studies, in which breakfast was provided at school over a longer period show positive effects on cognitive functioning. However, one cannot rule out that these positive effects are caused by breakfast consumption in itself, it might be caused by an increased school attendance due to breakfast provision at school (Hoyland et al., 2009). Furthermore it should be noted that findings on the relationship between frequency of breakfast consumption and cognitive functioning are inconsistent and difficult to compare because of different methodologies (i.e. different cognitive tests and control for different confounding factors) and definitions (i.e. definition of breakfast and breakfast skipping) (Rampersaud, 2008; Taras, 2005).

To explain the relationship between cognitive performance or school performance and frequency of breakfast consumption a variety of mechanisms have been proposed. A biological mechanism through which breakfast consumption might influence cognitive performance is the blood glucose level. During the night blood glucose levels drop due to fasting. Breakfast consumption causes the blood glucose level to increase again. This blood glucose level is important because glucose is the only energy source which the brain can utilize (e.g. Hoyland, 2009; Rampersaud, 2008). Moreover, breakfast can provide micronutrients that enhance cognitive functions such as iron and iodine (Adolphus, 2013).

In conclusion, a positive, short-term and domain specific relationship between frequency of breakfast consumption and cognitive functioning has been shown in multiple studies (Adolphus et al., 2016; Hoyland et al., 2009). Furthermore, a positive relationship between frequency of breakfast consumption and school performance was consistently found in diverse population samples (e.g. Adolphus et al., 2013). However, the relationship between frequency of breakfast consumption and school performance has not yet been studied in prevocational secondary education students.

1.2.2 Frequency of breakfast consumption and BMI in adolescents.

Overweight and obesity is a growing problem among adolescents in the Netherlands (Centraal Bureau voor de Statistiek, 2018a). An inverse association between frequency of breakfast consumption and BMI (i.e. higher frequency of breakfast consumption, lower BMI) in adolescents has been shown in many cross-sectional studies (e.g. Croezen et al., 2009; Dialektakou & Vranas, 2008; Keski-Rahkonen

et al., 2003; Szajewska & Ruszczyński, 2010; So et al., 2011; Tee et al., 2018). Frequency of breakfast consumption has been shown to be related to BMI, but this relationship could possibly be bidirectional. BMI might also influence the frequency of breakfast consumption; Mellin, Neumark-Sztainer, Story, Ireland, and Resnick, (2002) showed that breakfast skipping is more prevalent among overweighed adolescents than among adolescents with normal weight. A possible explanation is that adolescents with higher BMI choose to skip breakfast in order to lose weight (Keski-Rahkonen et al., 2003; Rampersaud et al., 2005; Rampersaud, 2008).

However, results of longitudinal investigations are mixed (Rampersaud, 2008). Barton et al.(2005) were not able to find a relationship between breakfast consumption and BMI in their ten-year longitudinal study when adjusting for demographic characteristics, physical activity and energy intake. In another three-year longitudinal study the association between BMI and breakfast consumption was shown to be different for overweight adolescents compared to normal weight adolescents (Berkey, Rockett, Gillman, Field, & Colditz, 2003). In normal weight adolescents who infrequently consumed breakfast BMI increased over time, whereas in their overweighed counterparts who infrequently consumed breakfast a decrease in BMI was shown.

When analysing their data cross-sectional and prospectively, Timlin, Pereira, Story and Neumark-Sztainer (2008) consistently found a negative association between frequency of breakfast consumption and BMI (i.e. higher frequency of breakfast consumption, lower BMI). Furthermore, an inverse association between dieting and frequency of breakfast consumption was found in the same population (i.e. more dieting, lower frequency of breakfast consumption) (Neumark-Sztainer, Wall, Haines, Story, & Eisenberg, 2007). Adjustment for dietary factors (e.g. daily energy and macronutrient intake) did not explain the relationship between breakfast frequency and BMI; however, further adjustment for weight-related concerns and perception partly explained the relationship between breakfast frequency and BMI (Timlin et al., 2008). These results thus suggest that the relationship between breakfast frequency and BMI is influenced by dieting.

Inconsistency of findings concerning the relationship between breakfast consumption and BMI might be explained by differences in study design, or control for different confounding factors (Rampersaud, 2008). Furthermore, different definitions and measurements of breakfast skipping (i.e. measurement of breakfast consumption at the day of research or recall of breakfast consumption over a longer period) can be determinative for study results (Dialektakou & Vranas, 2008).

It is not clear through what mechanisms breakfast consumption and BMI are associated. Breakfast consumption might increase satiety and consequently decrease energy intake through physiological changes such as glycaemic and insulin response (Rampersaud, 2008; Timlin & Pereira, 2007). Consumption of breakfast has also been linked to an overall better diet quality and healthy lifestyle (Barton et al., 2005; Keski-Rahkonen et al., 2003; Rampersaud, 2008; So et al., 2011; Timlin &

Pereira, 2007). For example, Keski-Rahkonen (2003) found that adolescents who skip breakfast frequently were likely to exercise less than their breakfast eating counterparts. This might suggest that the relationship between frequency of breakfast consumption and BMI is mediated by lifestyle choices. Another explanation for the relationship between frequency of breakfast consumption and BMI might be dieting behaviour to lose weight, adolescents with a higher BMI tend to skip breakfast more often, because they want to lose weight (Neumark-Sztainer et al., 2007; Timlin et al., 2008).

In summary, multiple studies have demonstrated an inverse relationship between frequency of breakfast consumption and BMI (e.g. Croezen et al.,2009; So et al., 2011; Tee et al., 2018). While cross-sectional findings on this relationship are consistent, longitudinal studies show more ambiguous results (Barton et al., 2005; Berkey et al., 2003; Rampersaud, 2008). Furthermore, the relationship between BMI and frequency of breakfast consumption is possibly bidirectional (Keski-Rahkonen et al., 2003; Rampersaud et al., 2005; Rampersaud, 2008).

1.2.3 BMI and school performance in adolescents.

In previous sections the associations of frequency of breakfast consumption with school performance and with BMI have been discussed. This section will discuss the association between BMI and school performance.

Some studies have shown a negative relationship between weight status and school performance (i.e. overweighed students, poorer performance than normal weight students) (Crosnoe & Muller, 2004; Shore et al., 2008), while others were only able to demonstrate this relationship in female participants (Booth et al., 2014). In addition, Larsen et al. (2014) demonstrated a relationship between BMI and a decline in educational level. Meaning that adolescents who had a higher BMI at the baseline measure were more likely to move to a lower educational level of secondary education the next year than their peers with a lower BMI. This relationship suggests poorer performance of students with a higher BMI due to which they dropped to a lower educational level. In contrast, Suchert, Hanewinkel and Isensee (2016) and Florence, Asbridge and Veugelers (2008) were not able to demonstrate an association between BMI and school performance when adjusting for sociodemographic confounders.

Clearly, studies concerning the relationship between BMI and school performance show inconsistent results. Caird et al. (2013) reviewed studies on the relationship between overweight and school performance. Although the results from the included studies were mixed (i.e. positive, negative and neutral relationships between BMI and school performance) the authors concluded that overall a weak negative association between those variables exists. However, this association decreases and sometimes lost significance when moderating variables such as social economic status are taken into account (Caird et al. 2013). The inconsistency among these results can be attributed to limitations of

studies such as cross-sectional design and lack of control for important confounders (Caird et al., 2013).

A number of potential underlying mechanisms that might explain the relationship between BMI and school performance have been suggested. Maayan, Hoogendoorn, Sweat and Convit (2011) directly related obesity to a lower cortical gray matter volume. They showed a lower orbitofrontal cortex volume in obese adolescents compared to their normal weight counterparts. The orbitofrontal cortex is a brain region which is, among other things, involved in inhibitory control, which in turn has been positively related to school performance (e.g. Best et al., 2011). Maayan et al. (2011) also related obesity in adolescents to lower scores on a variety of cognitive tests (e.g. Stroop colour-word test and WRAML working memory index). Indicating poorer inhibition and lower working memory in obese adolescents compared to their normal weight peers. Furthermore, overweight and obesity have been related to more mental and physical illness causing more school absenteeism, which can cause worse school performance (Pan, Sherry, Park, & Blanck, 2013). In addition, Crosnoe and Muller (2004) suggested that school context and stigmatization of obesity could also negatively influence school performance.

1.2.4 Possible role of frequency of breakfast consumption in the relationship between BMI and school performance.

As described in the section above a weak association between BMI and school performance might exist (Caird et al., 2013). Although a multitude of explanations of the relationship between BMI and school performance have been suggested, it remains unclear through what exact mechanism these two variables are related.

In the current study it was hypothesized that frequency of breakfast consumption might explain part of the relationship between BMI and school performance. This hypothesis was based on the thought that adolescents with higher BMI are more likely to skip breakfast in order to lose weight (Keski-Rahkonen et al., 2003; Neumark-Sztainer et al., 2007; Rampersaud et al., 2005; Rampersaud, 2008). This breakfast skipping behaviour in turn influences school performance through afore mentioned biological or nutritional mechanisms.

In addition, Florence et al. (2008) showed a relationship between overall diet quality, to which frequency of breakfast consumption is positively related (Barton et al., 2005; Keski-Rahkonen et al., 2003), and performance on a standardized literacy test. Florence et al. (2008) were however not able to find an independent relationship between BMI and performance on a standardized literacy test. These results suggest that diet quality might underlie the relationship between BMI and school performance, observed in other studies (e.g. Caird et al., 2013; Crosnoe & Muller, 2004; Shore et al., 2008). Since, frequency of breakfast consumption has been positively related to diet quality (Barton et al., 2005; Keski-Rahkonen et al., 2003; Rampersaud, 2008; So et al., 2011; Timlin & Pereira, 2007) it

might be possible that frequency of breakfast consumption plays a role in the relationship between BMI and school performance.

1.3 Research question and hypothesis

The relationship between the three variables: frequency of breakfast consumption, BMI and school performance of students in prevocational secondary education was the main subject of the present study. As described above all three variables are possibly related to each other. Therefore, the main question addressed in this study was: What is the relationship between BMI and school performance of prevocational secondary education students and does frequency of breakfast consumption play a mediating role in this relationship? It should be pointed out here that due to the limited possibilities of a master thesis, present study has to be considered an explorative pilot study. Results might contribute to future research on a larger scale.

Firstly we investigated the relationships between frequency of breakfast consumption, BMI and school performance. Therefore, the following three sub questions were addressed.

- What is the relationship between frequency of breakfast consumption and school performance in prevocational secondary education students?

A positive relationship between frequency of breakfast consumption and school performance (i.e. higher frequency of breakfast consumption, higher school grades) was hypothesized.

- What is the relationship between frequency of breakfast consumption and BMI in prevocational secondary education students?

A negative relationship between frequency of breakfast consumption and BMI (i.e. higher frequency of breakfast consumption, lower BMI) was hypothesized.

- What is the relationship between BMI and school performance in prevocational secondary education students?

A negative relationship between BMI and school performance (i.e. higher BMI, lower school grades) was hypothesized.

Lastly, frequency of breakfast consumption was analysed as a possible mediator in the relationship between BMI and school performance in prevocational secondary education students. To that end the following sub question have been addressed.

- Is the relationship between BMI and school performance mediated by frequency of breakfast consumption?

Concerning the last sub question it was hypothesized that frequency of breakfast consumption plays a mediating role in the relationship between BMI and school performance.

2. Methods

2.1 Design

The research that has been conducted is a cross-sectional design in which quantitative data was collected by means of a short student questionnaire (see Appendix A). Because the main aim of the study was to identify the direction and degree of association between several variables, a correlational design has been used. Although causality cannot be proven by this design, it is less time consuming and demanding than (quasi) experimental designs and, therefore, more suitable for the limited time and resources of a master thesis.

2.2 Participants

In the Netherlands there are three levels of secondary education. Pre-university education, senior general secondary education and prevocational secondary education. The latter is attended by approximately 52% of Dutch students and is further divided into four sublevels. Approximately 40% of students in prevocational secondary education are attending the highest sublevel; the theoretical learning pathway (Centraal Bureau voor de Statistiek, 2018b).

Because overweight (Vissers et al., 2008) and breakfast skipping behaviour (Raaijmakers et al., 2010) are most prevalent in adolescents attending lower educational tracks, students attending prevocational secondary education were recruited. This also complements the research by Boschloo et al. (2012), in which the relationship between breakfast consumption and school performance in the two highest secondary educational tracks was investigated.

Participants were recruited from a secondary school in the west of the Netherlands. They were in grade 7 to 10 of the theoretical learning pathway and aged between 12 and 17 years. To prevent bias, only students who attended the theoretical learning pathway from the first grade until their present grade without skipping or repeating grades were included in this study. As mathematics is not compulsory in the fourth grade and as mathematics was one of the outcome variables of the current study, students who did not take mathematics were excluded.

To determine the required sample size for a multiple regression analysis, a power analysis was conducted using G*Power (Faul, Erdfelder, Lang, & Buchner, 2007). The reported effect sizes from previous studies on the relationships between BMI and school performance (Caird et al., 2013), BMI and frequency of breakfast consumption (e.g. Croezen et al., 2009; So et al, 2011; Tee et al, 2018) and frequency of breakfast consumption and school performance (Boschloo et al., 2012; Lien, 2007) are all small. When using a small effect size in a power calculation; an (f^2) of .02, an alpha of .05, a power level of .80 and testing two predictors a minimum of 485 participants would be required for this study. In addition to this, it should be taken into account that due to multicollinearity in a mediation analysis slightly more participants would be needed (Kenny, 2018). Clearly, this required sample size is not feasible within the possibilities of a master thesis.

Although effect sizes reported in previous studies are a valuable contribution to an educated guess for expected results in current study, the subject population of this study is different from previous studies. Results might therefore diverge from previously found results. Nevertheless, due to limitations of a master thesis, this study had been characterized as an explorative pilot study.

Participation was voluntarily. The participating school had 283 students, 53 of them were excluded because they have repeated a grade or did not follow the theoretical learning pathway from the first grade until their present grade. Furthermore, 13 students were excluded because they do not take mathematics. The remaining 217 students and their parents/caregivers received an information letter and an informed consent form. To encourage students to participate, the researcher visited every class to inform the students about the research.

2.3 Materials

2.3.1 Independent variables

Different studies have used different definitions of breakfast. Keski-Rahkonen et al. (2003) defined breakfast as eating a morning meal at home, while Raaijmakers et al. (2010) included any food and drinks consumed before the first school break. In the present study breakfast has been defined as any food and drinks containing calories (i.e, >0 calories, not only coffee or tea) consumed in the morning before the first class, or during the weekend before 11 am.

Also the definitions of breakfast skipping and breakfast consumption vary. Some authors use three categories such as breakfast skippers, semi-skippers and consumers and take week and weekend days into account (e.g. Lien, 2007; So et al., 2011; Tee et al., 2018). Whereas others use dichotomous classifications and only measure breakfast consumption on weekdays (e.g. Boschloo et al., 2012).

Because Adolphus et al. (2013) stated that a dichotomous classification was insufficient to define habitual breakfast, in the current study it was decided to operationalise the independent variable (i.e. frequency of breakfast consumption) as an interval variable. Frequency of breakfast consumption had values ranging from 0 to 7, indicating the number of days per week that breakfast was consumed. Frequency of breakfast consumption has been measured in a short student questionnaire with the question: ‘How many days over the past week did you have breakfast?’ conform So et al. (2011). This question focusses on the last week, since that might be less confusing for participants than asking for averages over longer periods of time. Moreover as breakfast behaviour is considered stable (Wong & Mullan, 2009), this question provided the desired information.

Although the definition of breakfast was described in the questionnaire, a control question was added to the questionnaire to verify whether the food participants consumed has any caloric value; ‘Write down what you normally eat or drink for breakfast?’ This control question was added because personal experiences with prevocational secondary education students has taught that they are not the most accurate readers and, therefore, might miss the definition of breakfast.

Self-reported height and weight measures were derived from the student questionnaire. To calculate the values of the independent variable BMI the formula: weight in kilograms divided by the square of height in meters (kg/m_2) was used.

2.3.2 Dependent variable

School performance was the dependent variable in this study. School performance was operationalised as the mean of the end of term school grades for the subjects Dutch, English and mathematics combined, conform Boschloo et al. (2012). This method is preferred over the use of an achievement test because results are measured over a longer period instead of at one point in time, which makes results less sensitive to situational factors. Data on school performance were provided by the participating school. To compare school performance over grades, z-scores were calculated.

2.3.3 Covariates

Even though Boschloo et al. (2012) were not able to show age or sex specific differences in the relationship between frequency of breakfast consumption and school performance, age and sex were still considered to be possible confounders in this study. Brain development is found to be different at different ages (Gogtay et al., 2004) and glucose metabolism in the brain differs with age (Chugani, 1998). School performance scores and the effect of breakfast consumption on school performance might therefore be influenced by age. In contrast to Boschloo et al. (2012), Lien (2007) did find sex differences in the relationship between frequency of breakfast consumption and school performance. Furthermore, sex is known to be of influence on school performance (e.g. Legewie & DiPrete, 2012). BMI might also be influenced by age and sex. Results on these relationships are inconsistent. Botton et al. (2008) found different BMI scores in boys and girls, whereas Bitar, Vernet, Coudert and Vermorel (2000) were not able to find sex specific differences, they did find age related differences in BMI.

Socioeconomic status (SES) has been related to breakfast and school performance (Keski-Rahkonen et al., 2003; Rampersaud et al., 2005; Rampersaud, 2008) and to BMI (Rampersaud, 2008). Level of parental education (LPE) can be used as an indication for SES (Kaplan & Keil, 1993). Therefore, we choose to include LPE as a covariate.

To conclude, results of the present study have been controlled for age, sex and LPE. Age in years and sex were obtained from the students questionnaire (see Appendix A). Information on LPE was obtained from the parents/caregivers by a short questionnaire (see Appendix B) consisting of an ordinal eight-point scale ranging from primary education to post university education (De Bie, 1987). LPE was defined as the parent with the highest level of education, which is an indication for SES (Kaplan & Keil, 1993). LPE has been dichotomised into *low-medium* (vocational education level and below) and *high* (senior general secondary education and higher) conform Boschloo et al. (2012).

2.4 Procedure

After ethical approval by the Ethical Committee of the Open University (cETO) all potential participants and their parents/caregivers received an information letter and written informed consent by e-mail. According to the General Data Protection Regulation (GDPR) (AVG in The Netherlands) e-mail addresses of potential participants were not provided to the researcher; therefore, all recruitment e-mails were send by the participating school. In addition the researcher visited the potential participants during their classes to explain the aim and procedure of the study and handout a hard copy of the informed consent form. After one week the participating school did send a reminder e-mail to the parents/caregivers. To participate in the study parents/caregivers and adolescents both had to sign the consent form. As described above, students who did not follow the theoretical learning pathway from the first grade until the present grade or lack mathematics in their program were excluded.

Parents/caregivers who give their consent were consequently asked to fill out the LPE questionnaire, which was attached to the informed consent form. Participating adolescents were asked to fill out a short paper-and-pencil questionnaire to provide data about body height and weight, breakfast consumption, age, grade and gender. Filling out the student questionnaire took approximately 5 minutes and was supervised by the researcher or a teacher of the participating school. End of term school grades on the subjects Dutch, English and mathematics were provided by the participating school.

For privacy reasons all collected data was coded. Each participant received a participant code. One name-participant-code file was created, this file was and will only be accessible by the researchers. In all other files the participant code was used.

2.5 Analysis

To analyse data IBM SPSS statistics 25 has been used. First the data was visually inspected for normality and outliers (i.e. extreme high or low scores). Participants with missing values on essential variables were excluded. All interval variables were centralised and dichotomous variables were dummy coded. In addition, the variable school performance was standardized per grade, to make comparisons over grades possible. To determine the weight categories (i.e. normal weight, overweight, obesity) of the participants the age and gender specific BMI cut off values of the Dutch nutrition centre were used (Voedingscentrum, 2010).

To explore the relationships between BMI, school performance, frequency of breakfast consumption and the covariates (LPE, age and sex) and to answer the first three sub questions a hierarchical multiple regression analysis was conducted. The covariates (LPE, age and sex) were entered in the first step and BMI and frequency of breakfast consumption were added in the second step. To answer the last sub question concerning the possible mediation effect of frequency of breakfast consumption the SPSS macro PROCESS v. 3.2.1, written by Hayes (2012) was used.

3. Results

At the start of the study 217 adolescents and their parents/caregivers received an information letter and informed consent form. One week later all potential participants and their parents/caregivers received a reminder by e-mail and their classes were visited by the researcher again. After the planned recruitment period of two weeks 37 adolescents responded. Because of this small group of participants it was decided to enlarge and intensify the recruitment period. During the next two weeks the researcher visited classes several times to remind students. In addition, parents/caregivers were approached in person by the researcher at a parents evening of the participating school. These efforts resulted in a total of 68 respondents, which is approximately 31% of the prospective candidates.

In order to increase this limited number of participants four other schools were approached to participate in this research. One of these schools did not respond at all. Two schools indicated that they were not interested to participate due to lack of time and capacity. One school was interested and permitted recruitment. This school had only 32 students that meet the requirements of participation. These students and their parents/caregivers received an information letter and informed consent form. After a recruitment period of two weeks, none of the students had responded. This recruitment could not be intensified or enlarged as the researcher had limited access to the school.

One of the 68 respondents did not fill out essential information concerning the BMI on the questionnaire and two respondents did not provide information on LPE, these participants were excluded from analysis. The final sample consisted of 65 participants, 41.5% boys and 58.5% girls, aged 12 to 17 years (M = 14.03, SD = 1.46). 33.8% of the participants were in grade 1, 15.4% in grade 2, 21.5% in grade 3 and 29.2% in grade 4. LPE was low-medium in 47.7% and high in 52.3% of the participants.

Participants had an average breakfast frequency of 5 days per week (M = 5.09, SD = 2.31). The distribution of frequency of breakfast consumption was skewed with 47.7% of the participants consuming breakfast 7 days per week. The average BMI was 21 (SD = 3.11) with 81.5% of participants having a normal weight, 13.8 % having overweight and 4.6% having obesity. Grade and school grades were significantly correlated $r = .40$, $p < .01$. Therefore school grades, as a measure for school performance (M = 6.61, SD = .77) were standardized to z-scores per grade. Table 1 shows means, standard deviations and correlations between background variables, school performance, breakfast frequency and BMI.

Table 1

Means, standard deviations and Pearson correlations (N =65)

	M	*SD*	1	2	3	4	5	6	7	8
1. Age	14.03	1.46	—							
2. Grade	2.46	1.24	.90**	—						
3. Sex	—	—	-.02	-.01	—					
4. BMI	21.00	3.11	.34**	.32**	-.13	—				
5. Breakfast frequency	5.09	2.31	-.16	-.17	.13	-.17	—			
6. LPE	—	—	.11	.04	.08	-.09	-.07	—		
7. School performance.	6.61	.77	-.46**	-.40**	-.14	-.10	.24	-.13	—	
8. School performance. Z-scores per grade	.00	.98	-.12	0	-.14	.02	.19	-.10	.88**	—

Note. BMI = Body Mass Index; LPE = Level of Parental Education. **p<.01 (two-tailed).

3.1 Breakfast frequency, BMI and school performance

The first three research questions of the present study concerned the supposed relationships between, consecutively, breakfast frequency and school performance, breakfast frequency and BMI and BMI and school performance. In table 1 it is shown that the correlation between frequency of breakfast consumption and school performance (i.e. standardized school grades) and frequency of breakfast consumption and BMI were weak and not significant, r = .19, p = .13 and r = -.17, p = .19. The relationship between BMI and school performance was found to be nearly nil r = .02, p = .90.

Consequently, hierarchical multiple regression analysis with age, sex and LPE as background variables, breakfast frequency and BMI as predictors and standardized school grades as outcome variable also showed that these variables are not significantly related. Table 2 displays the results of this multiple regression analysis. Step 1 - with the background variables - explained 4% of the variance. In step 2 – where breakfast frequency and BMI were added – another 4.3% was explained. None of the coefficients were significant.

Based on these results sex (β = -.16, p = .22), age (β = -.10, p = .46), LPE (β = -.08, p = .52), breakfast frequency (β = .21, p = .11) and BMI (β = .06, p = .65) are found to be no significant predictors of school grades. Based on these results our hypothesises cannot be confirmed.

Table 2

Hierarchical multiple regression analysis predicting standardized school grades from breakfast frequency and BMI

	School grades	
Predictor	ΔR^2	β
Step 1	.04	
Sex		-.14
Age		-.11
LPE		-.07
Step 2	.04	
Sex		-.16
Age		-.10
LPE		-.08
BMI		.06
BF frequency		.21
Total R^2	.08	
n	65	

*Note***.** LPE = Level of Parental Education; BMI = Body Mass Index; BF = Breakfast. No significant values.

3.2 Mediation

In order to answer the final research question a mediation analysis was performed. This analysis added no valuable information, because no significant relationship between the predictor variable BMI and outcome variable standardized school grades was found. For the sake of completeness the results of the analysis are described here and displayed in figure 3.

The total effect of BMI on school performance is near nil and not significant (b = 0.01, p = .80). The total effect consist of a direct effect of BMI on school performance (b = 0.02, p = .67) and an indirect effect via frequency of breakfast consumption (b = -0.01, BCa 95% CI [-.03, .02]).

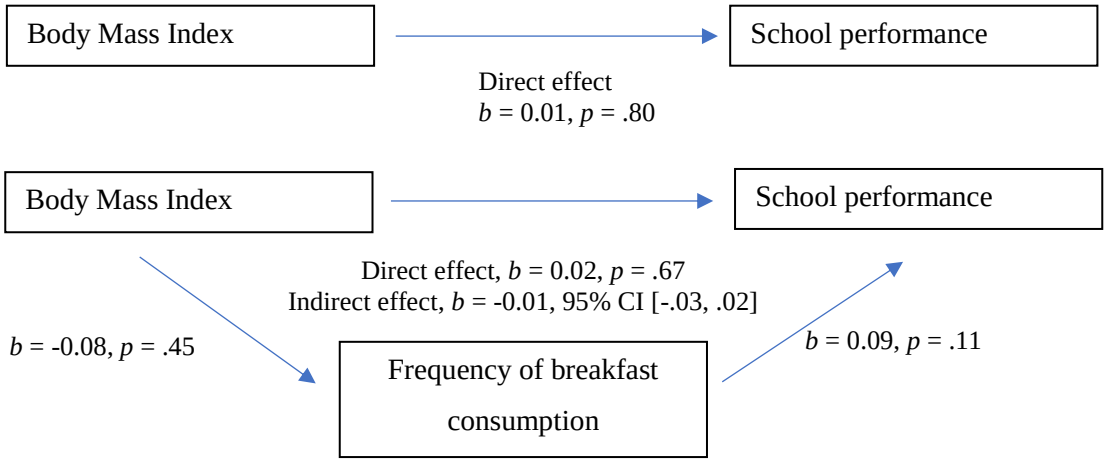

Figure 3. Model of BMI as predictor of school performance, mediated by frequency of breakfast consumption. Mediation is tested using the PROCESS macro for SPSS (Hayes, 2012). The confidence interval for the indirect effect is a BCa bootstrapped CI based on 5000 samples.

3.3 Explorative addition

One of the aims of this study was to expand the work of Boschloo et al. (2012), however there was a major difference in their methods. They dichotomized frequency of breakfast consumption in 'always' (i.e. every weekday, 5 times a week) and 'not always' (i.e. not every weekday, < 5 times a week), moreover they left weekend days out of consideration. To compare their results to ours we decided to execute additional explorative analyses with frequency of breakfast consumption dichotomized.

First our data was dichotomised on frequency of breakfast consumption to 'always'(i.e. every day, 7 times a week) n = 31 and 'not always' (i.e. not every day, < 7 times a week) n = 34. Subsequently an independent t-tests with bootstrapping based on 1000 samples (two-tailed, α = .05) with frequency of breakfast consumption as grouping variable and standardized school performance as dependent variable was performed. This test showed that on average, students who always consume breakfast have higher standardized school grades (M = 0.10, SE = 0.17) than those who do not consume breakfast every day (M = -0.09, SE = 0.18). This difference, -0.19, BCa 95% CI [-0.68, 0.30], was however not significant $t(63)$ = -0.78, p = .44 and with Cohen's d = .19 and Pearsons r = .10 it represents a very small effect. In addition, when frequency of breakfast consumption in the initial hierarchical regression analysis was replaced by dichotomous frequency of breakfast consumption the β was reduced to β = .11, p = .43. This leads to the conclusion that in current study no major difference in the relationship between frequency of breakfast consumption and standardized school grades were present when frequency of breakfast consumption was treated as a dichotomous variable, conform Boschloo et al. (2012).

Interestingly though, when frequency of breakfast consumption was dichotomized we did find a significant correlation between frequency of breakfast consumption and BMI (r = -.39, p < .01). Because BMI and age were also highly correlated (r = .34, p < .01) BMI was standardized over age, to

explore whether the correlation between frequency of breakfast (dichotomized) and BMI would last when controlled for age. An independent t-tests (two-tailed, $\alpha = .05$) with frequency of breakfast consumption as grouping variable and standardized BMI as dependent variable showed that on average, students who always consume breakfast have a significant lower standardized BMI (M = -0.27, SE = 0.14) than those who do not consume breakfast every day (M = 0.25, SE = 0.18). This difference, 0.52, BCa 95% CI [0.05, 0.98], was significant $t(59.347) = 2.22$, $p = .03$ and with Cohen's $d = .55$ and Pearsons $r = -.27$ it represents a medium effect. This means that students who consumed breakfast everyday had .27 standard deviation lower BMI than their peers who did not consume breakfast every day. With standard deviations ranging from 1.93 to 4.04 this means a difference of 0.5 to 1 BMI point.

4. Conclusions and Discussion

The first aim of present pilot study was to investigate the relationship between consecutively frequency of breakfast consumption and school performance, frequency of breakfast consumption and BMI, and between BMI and school performance in prevocational secondary education students. The second aim was to investigate whether frequency of breakfast consumption mediates the relationship between BMI and school performance. The main question addressed in this study was: What is the relationship between BMI and school performance of prevocational secondary education students and does frequency of breakfast consumption play a mediating role in this relationship?

4.1 The relationship between frequency of breakfast consumption and school performance

In contrast to our hypothesis we showed a non-significant but positive relationship between frequency of breakfast consumption and standardized school grades. Although not significant, the found relationship may well be valuable. The unstandardized regression coefficient β of frequency of breakfast consumption had a value of .21 for this sample, meaning that when frequency of breakfast consumption increases with one standard deviation (i.e. 2.31 days), standardized school grades increase with .21 standard deviation. With standard deviations of school grades ranging from 0.38 to 0.87, this means that an increase of breakfast frequency of 2.31 days a week predicts an average increase in school grades of 0.14. This is a meaningful difference, as school grades are calculated with one decimal. The fact that the results of this study were not significant does not mean that no relationship does exist in the population, to increase reliability a study with a larger study population is necessary.

In conclusion, we did find a small positive relationship between frequency of breakfast consumption and standardized school grades, this relationship was however not significant, therefore we were not able to confirm our first hypothesis. In previous research a significant, but small positive relationship between frequency of breakfast consumption and school grades has been found

consistently (Adolphus et al., 2013). This relationship was found when frequency of breakfast consumption was dichotomous (Boschloo et al., 2012; Kim et al., 2003; Lien, 2007), categorical (Gajre et al., 2008) or continuous (So, 2013). Moreover, Boschloo et al. (2012) dichotomized frequency of breakfast consumption and found a small positive, significant relationship (β = .15). Although we decided to operationalise frequency of breakfast consumption as an interval variable, because Adolphus et al. (2013) stated that a dichotomous classification was insufficient to define habitual breakfast, we exploratively dichotomized the variable to be able to compare our results with Boschloo et al. (2012). In contrast to the results of Boschloo et al, we were not able to show a significant relationship between the dichotomized frequency of breakfast consumption and standardized school grades (β = .11, p = .43).

An important difference between previous studies and current study is the number of participants. The number of participants in the aforementioned studies ranged from n = 379 (Gajre et al., 2008) to n = 75643 (So, 2013), in the present study was only 65 participants were included, which is the most important restriction of this study. Therefore, we determined a sample size for future research using the effect size found in this pilot study in a power calculation with G*Power (Faul et al., 2007). The R^2 = .04 of our multiple regression analysis was used to calculate the effect size, f^2= .04. For a power level of .95, an α = .05 and two predictors, a minimum of 390 participants would be required. This number of participants might yield a significant relationship between frequency of breakfast consumption and standardized school grades.

4.2 The relationship between frequency of breakfast consumption and BMI

Concerning the relationship between frequency of breakfast consumption and BMI we hypothesized a negative relationship. We were not able to confirm this hypothesis with our results. We did find a negative correlation between frequency of breakfast consumption and BMI with a small effect size, r = -.17, but this result was not significant, p = .19. In the majority of cross-sectional studies an inverse relationship between the frequency of breakfast consumption and BMI was shown (e.g. So et al., 2011; Tee et al., 2018). Dialektakou and Vranas (2008) noted that whether an association between frequency of breakfast consumption and BMI will be found depends on the definition of frequency of breakfast consumption. They found that studies that use variables corresponding to breakfast consumption on the day of data collection were more likely to find an association than studies that use variables corresponding to breakfast consumption during the previous week. They suggest that this difference is due to a less accurate recall of breakfast behaviour during the previous week than on the day itself. In present study it was a well-considered choice to collect data corresponding to the previous week, because results are more ecologically valid when investigated habits over a longer period than on one single day (Boschloo et al., 2012). So et al. (2011) and Tee et al. (2018) also collected data on the breakfast consumption of the previous week, and in contrast to our results they

did show a significant relationship between frequency of breakfast consumption and BMI. Since So et al. (2011) and Tee et al. (2018) used the same data collection method as the current study and they were able to show a significant positive relationship between frequency of breakfast consumption and BMI, the method of data collection (i.e. measurement of breakfast consumption at the day of research or recall of breakfast consumption over a longer period) does not seem to be a cause of our non-significant results.

Two main differences between previous research and present study that might explain the differences in results are: first, again the number of participants, which is very limited in the present study. Moreover, the spread of breakfast frequency and BMI were skewed. Of all participants 47.7% consumed breakfast every day and only 7.7% of the participants never consumed breakfast. Only 13.8% of the participants had overweight and 4.6% were obese. The skewed spread of the two variables combined with the limited number of participants can be of major influence on the results, therefore increasing the sample size might increase significance.

Second, the measurement level of frequency of breakfast consumption which is continuous in present study and categorical (i.e. three categories; breakfast skippers, semi-skippers and eaters) in the studies by So et al. (2011) and Tee et al. (2018). This difference in categorisation might have caused the differences in results. However due to the limited number of participants and the aforementioned skewed spread of frequency of breakfast consumption categorization in three groups was not possible, as this would have caused very small groups in the first two categories and this would not lead to valid results. When we however exploratively dichotomized the variable frequency of breakfast consumption into participants who ‘always’ consume breakfast (47.7%) and who ‘not always’ consume breakfast (52.3%) we did find a significant relationship between this variable and BMI (i.e. standardized BMI over age) $r = -.27$, $p = .03$.

4.3 The relationship between BMI and school performance

Although we hypothesized a negative relationship between BMI and standardized school grades, we were not able to find this relationship. Results from previous studies about the relationship between BMI and school performance were mixed. Caird et al. (2013) concluded in their review that a weak negative relationship between these two variables might exist. However, this association decreases when other factors such as social economic status were taken into account. In addition Taras and Potts-Datema (2005) reviewed articles on the relationship between weight status and school performance. They concluded that there is a limited amount of research on the subject, but a negative relationship between weight status and school performance was consistently found in the studies they reviewed. It should be noted that the reviewed researches compared normal weight to overweight or obesity and not to BMI as an continuous variable measure.

To our knowledge this is the first study in which the relationship between BMI and school performance in Dutch adolescents of the prevocational education was investigated, we were not able to show a significant relationship between BMI and school performance. However, due to the limited number of participants we cannot conclude that this relationship does not exist. More large scale research into the relationship between BMI and school performance in prevocational education is needed.

4.4 Mediation

We hypothesized that frequency of breakfast consumption could play a mediating role in the relation between BMI and school performance (i.e. standardized school grades). As we did not find an effect of BMI on standardized school grades, it is not very likely that a mediating effect of frequency of breakfast consumption on that relationship is present. This was confirmed by our mediation analysis in which a nearly nil indirect effect of BMI on school grades via frequency of breakfast consumption was found b = -0.01, BCa 95% CI [-.03, .02]. Consequently, our main research question was answered; frequency of breakfast consumption could not be identified as a mediator in the relationship between BMI and school performance.

4.5 Limitations and future research

First of all it should be noted that cross-sectional studies can never provide us with information about causality. Therefore longitudinal or experimental studies are necessary. In addition, although mediation analysis with results from cross-sectional studies are performed regularly and results can provide indications for experimental research, these results will be biased and are therefore controversial (Maxwell & Cole, 2007). Mediation analysis is more accurate when data is collected longitudinal.

We utilized self-reported height and weight status as a measure, this is sometimes presented as a weakness in design. However, this was refuted by Goodman, Hinden and Khandelwal (2000) whom showed a high correlation (r = .92) between BMI based on self-reported height and weight status and BMI based on directly measured height and weight. In addition, Caird et al. (2013) found no differences in the amount of association of BMI and school performance between studies with direct measured height and weight status and self-reported height and weight status.

As mentioned before, the limited number of participants is the main limitation of this study. Although it can be expected that research carried out in schools will yield a representative and large enough sample of adolescents, recruiting adolescents is challenging for various reasons. First school board and staff need to be convinced of the importance of the research to the extent that they are willing to invest time and effort (Ladin L'Engle, Pardun, & Brown, 2004). Second, students need to be convinced to participate and their parents need to provide written consent.

The first obstacle, convincing school board and staff, was initially not seen as a problem in the current study. The researcher has been an employee of the participating school until recently, therefore the relationship with all levels of the organisation (e.g. board, teachers, students) was good. The study was introduced to the school board and staff more than seven months before the recruitment started. The board and most of the teachers were interested in the research topic and willing to help. The researcher was intensely supported by the employee of the schools administration, she has invested a considerable amount of time and effort in the research. Moreover, the researcher was welcome in the school and classroom setting at any time. However at a later stage, when it became apparent that this particular school would not yield enough participants, persuading school boards of other schools to participate in the study became an obstacle. Main reason for this was the lack of time and capacity in this particular period of the schoolyear.

The second hurdle, convincing students and parents to participate, was a challenge from the beginning. Some students were concerned about confidentiality, even after extensive written and oral explanation of the procedure of data handling and storage. Specifying weight status in particular caused an obstacle for some adolescents.

Obtaining consent was the biggest barrier in the recruitment process. Students reported different reasons for not returning their consent form. Some forgot to ask their parents, or to return the form, or they lost the form. These causes of a lower response rate when active written consent is required were also reported by O'Donnell et al. (1997). Some other students literally told the researcher to be 'lazy' and do not want to make any effort without it being beneficial to themselves. Because we did not ask to return the form in all cases, even when parents actively refused participation, we are not able to differentiate between refusals and other causes for not returning forms. To get a clearer picture of parental consent this should be adjusted in future research.

Because recruiting adolescents can be challenging Aarons et al. (2001) suggested some methods to maximize participation. They suggested that, in order to establish a good relationship with school and its staff, explain and plan the study activities, it is best to plan at least six months recruitment time. This can partly explain why our 'last-minute' recruitment yielded no additional participants. Aarons et al. (2001) also stated that it can be very valuable to win the support of parents, they therefore suggested that attending parent evenings at schools can be helpful in the recruitment process. This tactic has also been used during the recruitment period of the current study, with moderate success.

Another effective method in the recruitment of adolescents is the provision of monetary incentives (Martinson et al., 2000; Treweek et al., 2013). However, giving adolescents monetary incentives might be considered unethical, the provision of a non-monetary incentive (e.g. a voucher or present) might be considered. This does however require financial resources which were not available

for this study. For future research such an investment is worth considering, because the low sample size of this study is not representative and has major influence on the reliability and validity of the results.

Expanding research on the relationship between frequency of breakfast consumption and school performance and frequency of breakfast consumption and BMI might be of social relevance, especially since overweight is a growing problem in the Netherlands. Due to greater awareness of the role of frequency of breakfast consumption in school performance and BMI the outcomes of this kind of research might affect the breakfast habits on micro level, including participants and their parents/caregivers. Parent awareness of breakfast habits and modelling behaviour has been found to be a predictor for breakfast habits in children and adolescents (Pearson, Biddle & Gorely, 2009). For this reason, on meso level schools can start information and promotion programmes on the importance of breakfast consumption, not only targeting their student, but parents/caregivers as well. Educational materials and lessons on the importance of breakfast consumption can be developed by schools. Besides, study results on this subject might stimulate schools to provide breakfast to their students. On macro-level, the Dutch government might start a nationwide campaign to encourage breakfast consumption. Ideally, the Dutch government might consider a policy concerning breakfast provision in primary and secondary schools. We recommend further investigation of the relationships between frequency of breakfast consumption, BMI and school performance on a larger scale.

To conclude, the results of this explorative pilot study were not powerful enough to draw strong conclusions about the relationships between frequency of breakfast consumption, school performance and BMI; however, the results indicate that there might be a relationship between frequency of breakfast consumption and standardized school grades and between frequency of breakfast consumption and BMI. No significant relationship between BMI and standardized school grades was found, mediation analysis was therefore no longer relevant in this study. However, the results of this study might lead to investigate the relationships between frequency of breakfast consumption and BMI and school performance in prevocational secondary education in the Netherlands on a larger scale.

5. References

Aarons, S., Rose, A., Walker, J., Lyles, B., Jenkins, R., & Raine, T. (2001). Enhancing recruitment and data quality in a junior high school-based teen pregnancy prevention study. *Evaluation and Program Planning, 24*(3), 277-285. doi:10.1016/S0149-7189(01)00019-2

Adolphus, K., Lawton, C. L., & Dye, L. (2013). The effects of breakfast on behavior and academic performance in children and adolescents. *Frontiers in Human Neuroscience, 7*. oi:10.3389/fnhum.2013.00425

Adolphus, K., Lawton, C. L., Champ, C. L., & Dye, L. (2016). The effects of breakfast and breakfast composition on cognition in children and adolescents: A systematic review. *American society for nutrition, 7*(suppl), 590S-612S. doi:10.3945/an.115.010256

Bartels, M., Rietveld, M. J. H., Van Baal, G. C. M., & Boomsma, D. I. (2012). Heritability of educational achievement in 12-year-olds and the overlap with cognitive ability. *Twin Research, 5*(6), 544-553. doi:10.1375/twin.5.6.544

Barton, B. A., Eldridge, A. L., Thompson, D., Affenito, S. G., Striegel-Moore, R. H., Franko, D. L., . . . Crockett, S. J. (2005). The relationship of breakfast and cereal consumption to nutrient intake and body mass index: The National Heart, Lung, and Blood Institute growth and health study. *Journal of the American Dietetic Association, 105*(9), 1383-1389. doi: 10.1016/j.jada.2005.06.003

Berkey, C. S., Rockett, H. R. H., Gillman, M. W., Field, A. E., & Colditz, G. A. (2003). Longitudinal study of skipping breakfast and weight change in adolescents. *International Journal Of Obesity, 27*, 1258. doi:10.1038/sj.ijo.0802402

Best, J. R., Miller, P. H., & Naglieri, J. A. (2011). Relations between executive function and academic achievement from ages 5 to 17 in a large, representative national sample. *Learning and Individual Differences, 21*(4), 327-336. doi:10.1016/j.lindif.2011.01.007

Bitar, A., Coudert, J., Vernet, J., & Vermorel, M. (2000). Longitudinal changes in body composition, physical capacities and energy expenditure in boys and girls during the onset of puberty. *European Journal of Nutrition, 39*(4), 157. doi:10.1007/s003940070019

Booth, J. N., Tomporowski, P. D., Boyle, J. M. E., Ness, A. R., Joinson, C., Leary, S. D., & Reilly, J. J. (2014). Obesity impairs academic attainment in adolescence: findings from ALSPAC, a UK cohort. *International Journal Of Obesity*, *38*, 1335. doi:10.1038/ijo.2014.40

Boschloo, A. (2012). *School performance in adolescents: An educational neuropsychology perspective* (Doctoral dissertation, Vrije Universiteit, Amsterdam, The Netherlands). Retrieved from https://research.vu.nl/ws/portalfiles/portal/42101573/complete+dissertation.pdf

Boschloo, A., Ouwehand, C., Dekker, S., Lee, N., de Groot, R., Krabbendam, L., & Jolles, J. (2012). The relation between breakfast skipping and school performance in adolescents. *Mind, Brain, and Education*, *6*(2), 81-88. doi:10.1111/j.1751-228X.2012.01138.x

Botton, J., Heude, B., Maccario, J., Ducimetière, P., Charles, M.-A., & group, F. S. (2008). Postnatal weight and height growth velocities at different ages between birth and 5 y and body composition in adolescent boys and girls. *The American Journal of Clinical Nutrition, 87*(6), 1760-1768. doi:10.1093/ajcn/87.6.1760

Caird, J., Kavanagh, J., O'Mara-Eves, A., Oliver, K., Oliver, S., Stansfield, C., & Thomas, J. (2013). Does being overweight impede academic attainment? A systematic review. *Health Education Journal, 73*(5), 497-521. doi:10.1177/0017896913489289

Centraal Bureau voor de Statistiek (Statistics Netherlands) (2018a). *Lengte en gewicht van personen, ondergewicht en overgewicht; vanaf 1981*. Retrieved from https://opendata.cbs.nl/statline/#/CBS/nl/dataset/81565NED/table?dl=F05A

Centraal Bureau voor de Statistiek (Statistics Netherlands) (2018b). *VO; leerlingen, onderwijssoort in detail, leerjaar*. Retrieved from http://statline.cbs.nl/StatWeb/publication/?VW=T&DM=SLnl&PA=80040NED&LA=nl

Chugani, H. T. (1998). A critical period of brain development: Studies of cerebral glucose utilization with PET. *Preventive Medicine, 27*(2), 184-188. doi:10.1006/pmed.1998.0274

Croezen, S., Visscher, T. L. S., ter Bogt, N. C. W., Veling, M. L., & Haveman-Nies, A. (2007). Skipping breakfast, alcohol consumption and physical inactivity as risk factors for overweight and obesity in adolescents: results of the E-MOVO project. *European Journal of Clinical Nutrition, 63*, 405. doi:10.1038/sj.ejcn.1602950

Crosnoe, R., & Muller, C. (2004). Body mass index, academic achievement, and school context: Examining the educational experiences of adolescents at risk of obesity. *Journal of Health and Social Behavior, 45*(4), 393-407. doi:10.1177/002214650404500403

Deary, I. J., Strand, S., Smith, P., & Fernandes, C. (2007). Intelligence and educational achievement. *Intelligence, 35*(1), 13-21. doi:https://doi.org/10.1016/j.intell.2006.02.001

De Bie, S. E.(1987). *Standaardvragen 1987: voorstellen van uniformering van vraagstelling naar achtergrondkenmerken en interviews*. Leiden, Nederland: Leiden University Press.

Dialektakou, K. D., & Vranas, P. B. M. (2008). Breakfast skipping and body mass index among adolescents in Greece: Whether an association exists depends on how breakfast skipping is defined. *Journal of the American Dietetic Association, 108*(9), 1517-1525. doi:10.1016/j.jada.2008.06.435

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior research methods, 39*(2), 175-191.

Florence, M. D., Asbridge, M., & Veugelers, P. J. (2008). Diet quality and academic performance*. *Journal of School Health, 78*(4), 209-215. doi:10.1111/j.1746-1561.2008.00288.x

Gogtay, N., Giedd, J. N., Lusk, L., Hayashi, K. M., Greenstein, D., Vaituzis, A. C., Nugent, T. F., Herman, D. H., Clasen, L. S., Toga, A. W., Rapoport, J. L., & Thompson, P. M. (2004). Dynamic mapping of human cortical development during childhood through early adulthood. *Proceedings of the National Academy of Sciences of the United States of America, 101*(21), 8174-8179. doi: 10.1073/pnas.0402680101

Goodman, E., Hinden, B. R., & Khandelwal, S. (2000). Accuracy of teen and parental reports of obesity and body mass index. *Pediatrics, 106*(1), 52-58.

Hayes, A. F. (2012). PROCESS: A versatile computational tool for observed variable mediation, moderation, and conditional process modeling: University of Kansas, KS.

Hoyland, A., Dye, L., & Lawton, C. L. (2009). A systematic review of the effect of breakfast on the cognitive performance of children and adolescents. *Nutrition research reviews, 22,* 220-243. doi:10.1017/S0954422409990175

Johnson, K., Bryant, D., Rockwell, D., Moore, M., Straub, B. W., Cummings, P., & Wilson, C. (1999). Obtaining Active Parental Consent for Evaluation Research: A Case Study. *American Journal of Evaluation, 20*(2), 239-249. doi:10.1177/109821409902000206

Kaplan, G. A., & Keil, J. E. (1993). Socioeconomic factors and cardiovascular disease: a review of the literature. *Circulation, 88*(4), 1973-1998.

Kenny, D.A. (2018). *Mediation.* Retrieved from http://davidakenny.net/cm/mediate.htm#DI

Keski-Rahkonen, A., Kaprio, J., Rissanen, A., Virkkunen, M., & Rose, R. J. (2003). Breakfast skipping and health-compromising behaviors in adolescents and adults. *European Journal of Clinical Nutrition, 57*(7), 842-853. doi:10.1038/sj.ejcn.1601618

Ladin L'Engle, K., Pardun, C. J., & Brown, J. D. (2004). Accessing adolescents: a school-recruited, home-based approach to conducting media and health research. *The Journal of Early Adolescence, 24*(2), 144-158. doi: 10.1177/0272431603262668

Larsen, J. K., Kleinjan, M., Engels, R. C., Fisher, J. O., & Hermans, R. C. (2014). Higher weight, lower education: a longitudinal association between adolescents' body mass index and their subsequent educational achievement level? *Journal of School Health, 84*(12), 769-776. doi:10.1111/jpsh.12212

Legewie, J., & DiPrete, T. A. (2012). School Context and the Gender Gap in Educational Achievement. *American Sociological Review, 77*(3), 463-485. doi:10.1177/0003122412440802

Lien, L. (2007). Is breakfast consumption related to mental distress and academic performance in adolescents? *Public Health Nutrition, 10*(4), 422-428. doi:10.1017/S1368980007258550

Maayan, L., Hoogendoorn, C., Sweat, V., & Convit, A. (2011). Disinhibited eating in obese adolescents is associated with orbitofrontal volume reductions and executive dysfunction. *Obesity, 19*(7), 1382-1387. doi:10.1038/oby.2011.15

Martinson, B. C., Lazovich, D., Lando, H. A., Perry, C. L., McGovern, P. G., & Boyle, R. G. (2000). Effectiveness of Monetary Incentives for Recruiting Adolescents to an Intervention Trial to Reduce Smoking. *Preventive Medicine, 31*(6), 706-713. doi:https://doi.org/10.1006/pmed.2000.0762

Maxwell, S. E., & Cole, D. A. (2007). Bias in cross-sectional analyses of longitudinal mediation. *Psychological Methods, 12*(1), 23-44. doi:10.1037/1082-989X.12.1.23

Mellin, A. E., Neumark-Sztainer, D., Story, M., Ireland, M., & Resnick, M. D. (2002). Unhealthy behaviors and psychosocial difficulties among overweight adolescents: the potential impact of familial factors. *Journal of Adolescent Health, 31*(2), 145-153.

Neumark-Sztainer, D., Wall, M., Haines, J., Story, M., & Eisenberg, M. E. (2007). Why does dieting predict weight gain in adolescents? Findings from project EAT-II: A 5-year longitudinal study. *Journal of the American Dietetic Association, 107*(3), 448-455. doi: 10.1016/j.jada.2006.12.013

O' Donnell, L. N., Duran, R. H., San Doval, A., Breslin, M. J., Juhn, G. M., & Stueve, A. (1997). Obtaining written parent permission for school-based health surveys of urban young adolescents. *Journal of Adolescent Health, 21*(6), 376-383. doi: 10.1016/S1054-139X(97)00108-0

Pan, L., Sherry, B., Park, S., & Blanck, H. M. (2013). The association of obesity and school absenteeism attributed to illness or injury among adolescents in the United States, 2009. *Journal of Adolescent Health, 52*(1), 64-69. doi:10.1016/j.jadohealth.2012.04.003

Pearson, N., Biddle, S. J. H., & Gorely, T. (2009). Family correlates of breakfast consumption among children and adolescents. A systematic review. *Appetite, 52*(1), 1-7. doi: 10.1016/j.appet.2008.08.006

Raaijmakers, L. G. M., Bessems, K. M. H. H., Kremers, S. P. J., & van Assema, P. (2010). Breakfast consumption among children and adolescents in the Netherlands. *European Journal of Public Health, 20*(3), 318-324. doi:10.1093/eurpub/ckp191

Rampersaud, G. C. (2008). Benefits of Breakfast for Children and Adolescents: Update and Recommendations for Practitioners. *American Journal of Lifestyle Medicine, 3*(2), 86-103. doi:10.1177/1559827608327219

Rampersaud, G. C., Pereira, M. A., Girard, B. L., Adams, J., & Metzl, J. D. (2005). Breakfast habits, nutritional status, body weight, and academic performance in children and adolescents. *Journal of the American dietetic association, 105*(5), 743-760. doi:10.1016/j.jada.2005.02.007

Shore, S. M., Sachs, M. L., Lidicker, J. R., Brett, S. N., Wright, A. R., & Libonati, J. R. (2008). Decreased scholastic achievement in overweight middle school students. *Obesity, 16*(7), 1535-1538. doi:10.1038/oby.2008.254

So, H. K., Nelson, E. A. S., Li, A. M., Guldan, G. S., Yin, J., Ng, P. C., & Sung, R. Y. T. (2011). Breakfast frequency inversely associated with BMI and body fatness in Hong Kong Chinese children aged 9–18 years. *British Journal of Nutrition, 106*(5), 742-751. doi:10.1017/S0007114511000754

Suchert, V., Hanewinkel, R., & Isensee, B. (2016). Longitudinal relationships of fitness, physical activity, and weight status with academic achievement in adolescents. *Journal of School Health, 86*(10), 734-741. doi:10.1111/josh.12424

Szajewska, H., & Ruszczyński, M. (2010). Systematic review demonstrating that breakfast consumption influences body weight outcomes in children and adolescents in Europe. *Critical Reviews in Food Science and Nutrition, 50*(2), 113-119. doi:10.1080/10408390903467514

Taras, H. (2005). Nutrition and student performance at school. *Journal of School Health, 75*(6), 199-213. doi:10.1111/j.1746-1561.2005.00025.x

Taras, H., & Potts-Datema, W. (2005). Obesity and Student Performance at School. *Journal of School Health, 75*(8), 291-295. doi:10.1111/j.1746-1561.2005.00040.x

Tee, E. S., Nurliyana, A. R., Norimah, A. K., Jan Mohamed, H. J. B., Tan, S. Y., Appukutty, M.,Hopkins, S., Thielecke, F., Kim Ong, M., Ning, C., & Nasir, M. T. M. (2018). Breakfast consumption among Malaysian primary and secondary school children and relationship with body weight status-Findings from the MyBreakfast Study. *Asia Pacific journal of clinical nutrition, 27*(2). doi:10.6133/apjcn.06207.12

Timlin, M. T., & Pereira, M. A. (2007). Breakfast frequency and quality in the etiology of adult obesity and chronic diseases. *Nutrition Reviews, 65*(6), 268-281. doi:doi:10.1111/j.1753-4887.2007.tb00304.x

Timlin, M. T., Pereira, M. A., Story, M., & Neumark-Sztainer, D. (2008). Breakfast eating and weight change in a 5-Year prospective analysis of adolescents: Project EAT (Eating Among Teens). *Pediatrics, 121*(3), e638.

Treweek, S., Lockhart, P., Pitkethly, M., Cook, J. A., Kjeldstrøm, M., Johansen, M., Taskila, T. K., Sullivan, F. M., Wilson, S., Jackson, C., Jones, R., Mitchell, E. D. (2013). Methods to improve recruitment to randomised controlled trials: Cochrane systematic review and meta-analysis. *BMJ Open, 3*(2), e002360. doi:10.1136/bmjopen-2012-002360

Vissers, D., Devoogdt, N., Gebruers, N., Mertens, I., Truijen, S., & Van Gaal, L. (2008). Overweight in Adolescents: Differences per Type of Education. Does One Size Fit All? *Journal of Nutrition Education and Behavior, 40*(2), 65-71. doi:10.1016/j.jneb.2007.06.010

Voedingscentrum. (2010). *BMI jongens en meisjes.* Retrieved at 11 juli, 2019, from http:// www.voedingscentrum.nl/professionals/kindervoeding-0-4-jaar/babyenkindervoeding/bmi-jongens-en-meisjes.aspx.

Williams, P. (2007). Breakfast and the diets of Australian children and adolescents: an analysis of data from the 1995 National Nutrition Survey. *International Journal of Food Sciences & Nutrition, 58*(3), 201-216. doi:10.1080/09637480701198075

Wong, C. L., & Mullan, B. A. (2009). Predicting breakfast consumption: An application of the theory of planned behaviour and the investigation of past behaviour and executive function. *British Journal of Health Psychology, 14*(3), 489-504. doi:10.1348/135910708X360719

6. Appendices

Appendix A: Student questionnaire

Vragenlijst voor het wetenschappelijk onderzoek:

De mediërende rol van ontbijt consumptie in de relatie tussen BMI en schoolprestatie.

Instructie voor de deelnemer:

Vul hieronder duidelijk je voor- en achternaam in.

Beantwoord vervolgens <u>alle</u> vragen op de volgende pagina zo eerlijk mogelijk.

Zorg dat de bladen niet los van elkaar raken.

Voornaam: ……..

Achternaam:……..

1. Wat is je geslacht? (kruis aan wat van toepassing is)

O Man
O Vrouw

2. In welk leerjaar zit je? (kruis aan wat van toepassing is)

O leerjaar 1
O leerjaar 2
O leerjaar 3
O leerjaar 4

3. Wat is je geboortedatum?

Ik ben geboren op: ……..-…….-……..

4. Wat is je lengte in centimeters?

Ik ben .....cm. lang

5. Wat is je gewicht in kilogram

Ik weeg ……kg.

De volgende vragen gaan over je ontbijtgewoonten. In dit onderzoek verstaan we onder ontbijt alles wat je eet of drinkt voor je eerste les op school. Of, op dagen dat je vrij bent, voor 11 uur in de ochtend. Er moeten wel calorieën in je eten of drinken zitten, dus alleen thee, water of koffie telt niet mee.

6. Hoeveel dagen heb je de afgelopen week ontbijt gehad? (kruis aan wat van toepassing is)

O 0 keer
O 1 keer
O 2 keer
O 3 keer
O 4 keer
O 5 keer
O 6 keer
O 7 keer

7. Schrijf op wat je normaal gesproken voor ontbijt eet of drinkt.

……
……

Bedankt dat je aan dit onderzoek wilde deelnemen.

Appendix B: Questionnaire on LPE

Vragenlijst opleidingsniveau ouders

Zoals vermeld in de informatiebrief van uw kind vragen wij u om onderstaande gegevens in te vullen. Deze gegevens zijn nodig om de validiteit van het onderzoek te maximaliseren. Uiteraard worden ook deze gegevens geanonimiseerd en vertrouwelijk behandeld, zoals beschreven in de informatiebrief.

OPLEIDINGSNIVEAU **WAT IS DE HOOGST GENOTEN OPLEIDING, AL DAN NIET VOLTOOID?** *(Hieronder voor vader/moeder en/of verzorger(s) het juiste antwoord aankruisen.)*				
Vader	Moeder	Verzorger 1*	Verzorger 2*	Hoogst genoten opleiding:
☐	☐	☐	☐	1. **Lager onderwijs** (bv. basisonderwijs, of een gedeelte hiervan)
☐	☐	☐	☐	2. **Lager beroepsonderwijs (LBO)** (bv. LTS, LHNO (Lager Huishoud- en Nijverheidsonderwijs), VMBO-BB, VMBO-KB, VMBO-GL, VBO)
☐	☐	☐	☐	3. **Middelbaar algemeen onderwijs** (bv. LAVO, VGLO, ULO, MULO, MAVO-3, MAVO-4, 3-jarige HBS, Middenschool, 3 jaar HAVO, VMBO-TL)
☐	☐	☐	☐	4. **Middelbaar beroepsonderwijs (MBO)** (bv. MTS, UTS, MEAO, Middelbaar Middenstandsdiploma)
☐	☐	☐	☐	5. **Voortgezet algemeen onderwijs** (bv. 5-jarige HBS, MMS, VWO Atheneum, VWO Gymnasium, Lyceum, HAVO)
☐	☐	☐	☐	6. **Hoger beroepsonderwijs (HBO)** (bv. HTS, HEAO, Leraren Opleiding, MO-A, MO-C, Ingenieursfase nieuwe stijl, HBO-Bachelor, HBO-Master)
☐	☐	☐	☐	7. **Hoger algemeen onderwijs/Wetenschappelijk onderwijs (WO)** (bv. Kandidaatsexamen oude stijl, Propedeuse, Doctoraal, WO-Bachelor, WO-Master)
☐	☐	☐	☐	8. **Post-HBO/Post-Universitair onderwijs** (bv. Promotie (Dr.), NIVRA (slotfase), Actuaris, MO-B, Hogere Krijgsschool)
☐	☐	☐	☐	9. **Anders,** namelijk:

* = alleen invullen indien van toepassing.